Prime End Users View of Future Supply Chain Issues and Strategies

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Abstract

The M777A1 is a lightweight 155mm howitzer and is a critical fire support component of U.S. Marine Air Ground Task Forces and U.S. Army Stryker Brigade Combat Teams. The M777A1 is the first ground combat system to make extensive use of titanium as fabricated parts and investment castings. This significantly reduces the weight of the howitzer offering improved transportability and mobility while retaining the full ammunition and range capability of the M198 howitzer it replaces.

The M777A1 is assembled at BAE System’s integration facility in Hattiesburg, MS and incorporates components manufactured in the United States, United Kingdom and Italy. In addition to the distribution logistics of a transatlantic supply chain, the programme also presents challenges in terms of price pressure on material and shipping costs.

The paper gives a perspective on current and future issues facing the program with an overview of the strategy for continuing forward with an effective supply chain solution.

1. Introduction

M777A1 is the world’s first 155mm Howitzer weighing less than 10,000lbs. Selected by the US Marine Corps and US Army as their next generation Medium Force weapon, the gun has undergone an Engineering and Manufacturing Development (EMD) programme in the USA. This led to an initial contract for 94 guns in November 2002 followed by a further contract for 495 guns in March 2005. M777A1 is now in full rate production for the US Armed Forces and is the benchmark for 155mm Lightweight Towed artillery Systems.

Highly mobile on land, at sea and in the air, the M777A1 has increased survivability through unsurpassed tactical and strategic mobility, low thermal and radar signature, rapid emplacement / displacement and a low silhouette. It fires all current and development US and NATO standard 155mm projectiles and charges.

The majority of materials, components and sub-assemblies are sourced within the Unites States. The Elevating Mass and the Saddle sub-assemblies are produced in BAE Systems’ plant in Barrow-in-Furness, England. Final assembly is carried out by BAE Systems in Hattiesburg, Mississippi. One example of the complexity of the supply chain sees titanium investment castings produced in Michigan and Virginia being shipped to the UK for machining and assembly to then be transported to Mississippi for final assembly into the gun. Another example shows castings from Oregon shipped to California for assembly with running gear and plates from the UK, aluminum castings from California and Government Furnished Equipment from New York and New Jersey to produce the lower carriage that then ships to Mississippi.
2. Development of the Product

Originally this gun was designated as UFH (Ultra-lightweight Field Howitzer) and was offered as a solution to the US Marine Corps as far back as 1987. Since then the product has undergone continuous development and evaluation. Testing has been extensive with over 10,000 rounds fired, the gun being towed over several thousand miles and trials undertaken in arctic and desert conditions. The lightweight design is achieved by the low trunnion height and the use of titanium and aluminum as an alternative to steel.

The use of titanium in the main structures supporting the ordnance is significant. The original design used over 770 fabricated plates. During the development of the gun this has significantly reduced with the introduction of 28 castings. Using castings rather than fabricating parts considerably improves fatigue life in addition to the benefits achieved through reductions in welding and pre-machining.

During 1995 both the US Marine Corps and the US Army approved a Joint Operational Requirements Document (JORD). The contract for Engineering and Manufacturing Development was awarded in March 1997 with 8 guns delivered in 2002. A Low Rate Initial Production (LRIP) contract for 94 guns was awarded in November 2002 and final delivery for these guns will take place during 2006. Following the success of the LRIP contract a further Full Rate Production (FRP) contract was awarded in March 2005 for a further 495 guns. These will be delivered to both the Marines and the Army through to 2009. The FRP guns will be upgraded to include a digital fire control system (DFCS) which will be retrofitted to the guns supplied under the LRIP contract. The DFCS was developed as a pre-planned product improvement to the M777. It uses inertial navigation together with GPS and vehicle motion sensor to accurately locate and point the howitzer and digitally interfaces with the existing Army / Marine Corps fire control system.

3. Supply Chain Issues and Strategies

With so many outsourced materials, components and sub assemblies the performance of the supply chain in terms of quality, schedule and cost is critical to the success of the M777A1 program.

Key issues are as follows:

- Consistency of product to the necessary quality requirements
- Schedule performance to support the ramp up to full rate production quantities and the provision of spares support
- Control of costs
- Communications

Strategies to deal with these issues are as follows:

Quality:

All critical to quality components are subject to a first article inspection that is typically applied to the first 5 production items. This includes a dimensional review.

Advanced Quality Planning (AQP) has been introduced into the contractual arrangements with key suppliers.

Schedule:

Suppliers have been assessed for their capability to ramp up to full rate production levels. Capital investment programmes to increase capability and capacity are tracked. Buffer stocks are programmed into the supply chain to preserve schedule.

We are working with suppliers to cover potential spares requirements with additional production stock which can be consumed later in the build programme if a support need does not arise.

Cost:

We have worked with suppliers to achieve non-variable pricing for the FRP contract. A series of initiatives have already taken place during the prototyping, development and LRIP phases to improve configuration of parts, improve productionability and to reduce costs.

A cross functional Continuous Improvement team reviews and manages opportunities to take cost out of the program. Contractual arrangements are in place with the suppliers and the customer to share benefits.

Schedules and logistical arrangements are developed to maximise the manufacturing cells in the Barrow facility.

- Titanium castings produced by a supplier in Michigan and Virginia are marshalled at their logistics centre in Indiana where they are containerised in complete gun sets and shipped to the UK.
- A truck tours a pre-determined route around the UK to deliver and collect items across the UK supply chain. Special boxes are used to hold complete gun sets of parts from specific suppliers. Items that need a coating operation are delivered to that supplier one week and then collected the next week when the coating operation has been completed.

Communications:

The supply chain is spread over a nine hour time zone differential from the US West Coast to Rome in Italy.

Integrated Project Team (IPT) meetings are typically held with suppliers on a weekly basis. Formal business reviews are held every Quarter.
BAE Systems is a founding partner in Exostar, the leading provider of secure collaboration and integrated supply-chain solutions to the aerospace and defense (A&D) industry. We are developing our capability to use e-Business as routine. We have developed interfaces between our SAP ERP systems through Exostar to our Supply Chain. Orders raised in SAP can be sent straight to the desktop of a supplier. There is a similar capability for RFQs using the Exostar Source Pass tool and we are currently piloting the use of Forum Pass to share and manage documentation with suppliers.

4. Conclusion

Relative stability in the supply chain over the lifecycle of the program has already delivered significant benefits to the design and cost model for the gun. Going forward the supply chain needs to continue to seek opportunities for improvement. Although many benefits have already been achieved through design and engineering we will continue to analyse value for money to seek further opportunities. This is not just limited to the product. Processes will also continue to come under scrutiny. The capability provided by Exostar is an excellent opportunity to improve efficiencies and communications within the supply chain. Exostar gives us the opportunity to transmit orders, schedules, RFQs to our suppliers directly from our ERP system. Also, by placing an order electronically our suppliers can invoice electronically reducing processing time.
Prime End users View of Supply Chain Issues & Strategies
Steve Grisdale
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M777A1 Lightweight 155mm Howitzer

- World’s first 155mm Howitzer weighing less than 10,000lbs
- Selected by US Marine Corps and US Army
- Increased survivability through high mobility, low thermal and radar signature, rapid emplacement / displacement and a low silhouette
- Fires all current and development US and NATO 155mm projectiles and charges
- Majority of materials, components and sub-assemblies sourced within the United States
- Final assembly carried out in Hattiesburg, Mississippi
Program Development

- Originally designated as UFH (Ultra-lightweight Field Howitzer) and offered as a solution to US Marine Corps in 1987
- US Marine Corps and US Army approved a Joint Operational Requirements Document (JORD) during 1995
- Contract for Engineering and Manufacturing Development (EMD) awarded in March 1997 (8 UK manufactured guns plus 2 production prototypes manufactured in USA delivered by 2002)
- Contract for Low Rate Initial Production (LRIP) awarded in November 2002 for 94 M777 guns. Final LRIP gun delivered September 2006
- Contract for Full Rate Production (FRP) awarded in March 2005 for 495 M777A1 howitzers to be delivered through to 2009.
Product Development

- The lightweight design gives improved mobility and transportability compared to the current M198 Howitzer
- Weight reduction achieved by having a low trunnion height and by using titanium and aluminum rather than steel
- Original design had over 770 fabricated plates. This has now been massively reduced with the introduction of 28 castings
- Castings give the technical advantage of improved fatigue life plus the cost advantage of reduced welding and pre-machining
- The FRP howitzers are upgraded to include a digital fire control system (DFCS.) These will be retro-fitted to the LRIP guns. This is a pre-planned product improvement using inertial navigation with GPS and vehicle motion sensors.
- Testing of the howitzer has been extensive
Product Sub-assemblies
M777A1 Supply Chain

- Majority of supply chain value resides in USA
- Elevating Mass and Saddle sub-assemblies are produced at Barrow facility in the UK using materials and components supplied from USA and UK
- Supply chain to Barrow facility includes titanium castings from Michigan and Virginia, titanium materials from Ohio, aluminum castings from California
- Body sub-assembly is produced in California using titanium castings from Oregon, hydro-struts and titanium plate from the UK and GFE parts from New York and New Jersey
- Final assembly takes place at facility in Hattiesburg, MS using sub-assemblies provided by first tier suppliers in USA, Italy and Barrow, UK.
M777A1 Supply Chain Issues

• Consistency of products to the necessary quality requirements

• Schedule performance to support the ramp up to full rate production levels and to provide spares support

• Control of costs

• Communications
M777A1 Supply Chain Strategy

• QUALITY: First Article Inspection and Advanced Quality Planning

• SCHEDULE: Supplier FRP Assessments, Buffer stocks for production support and customer support

• COST: Continuous Improvement, Logistic initiatives

• COMMUNICATIONS: Regular IPT meetings, Quarterly Business Reviews, Monthly Executive IPT with customer, Supplier Conferences

• E-BUSINESS: Exostar
E-Business

- BAE Systems is a founding partner in Exostar, the leading provider of secure collaboration and integrated supply-chain solutions to the A&D industry

- Capability in place to interface SAP ERP system with suppliers’ desk top or ERP system for orders, schedules, RFQ’s and invoicing

- Forum Pass capability to enable collaboration with supply chain
Conclusion

• Long development program and relative stability in supply chain has already delivered significant benefits to the design and cost model for the gun.

• Continue to seek opportunities for improvement. As design opportunities become exhausted, look to process.

• Exploit the e-Business opportunity. Investment already made to develop Exostar and to interface into ERP system.